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An evaluation of certain chemical factors affecting Trophic Level Status of Freshwater Ecosystems of Bhandara District of Central India

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Abstract

The present study was carried out to determine the trophic status of the freshwater resources of the Bhandara District of the central India. The Bhandara District is renowned for its lakes and is one of the Districts in India with highest number of lakes. For the purpose this study, total eleven different lakes were selected, and care was taken that the entire District is represented. Water samples were collected and processes by following standard methods and the generated data was statistically analysed using PASW 18.0 software. The results showed that the total phosphorous and total nitrogen were fairly. Also, the transparency was relatively less and overall most of the lakes were found to be of mesotrophic nature. Thus, it is concluded from the study results that majority of lakes in the Bhandara District face severe nutrient pollution and are at risk of becoming Eutrophic in near future.

Keywords: *Freshwater, phosphorous, nitrogen, chlorophyll a, trophic status*

Introduction

Water is one of the abundantly available substances in nature, which man has exploited more than any other resources for the sustenance of life. Water of good quality is required for living organisms. However, most water bodies have become contaminated due to incorporation of untreated solid and liquid waste. Furthermore, smaller as well as larger towns in India are situated near the lakes, and dams, their run off and those from agricultural lands find their way to these water bodies and makes them unfit for human use. Nowadays due to increased human population and man-made conditions, the water quality is deteriorating everywhere (Jayabhaye et al., 2008). The contents of growth – the composition of inputs (including ecological resources) and outputs (including waste products)—determined by, among other things, the economic institutions within which human activities are conducted, is critical for human development. These institutions need to be understood to appreciate the correct incentives for providing and protecting the resilience of aquatic ecological systems. Protecting the precious aquatic ecological systems to sustain welfare is of as much importance to poor countries as it is to the rich (Khanna *et al*., 1999).

In view of the importance of aquatic ecosystem as resources of freshwater for the humans, their health is very significant, as it is necessary for sustainable development of humans. Human health and many of the activities are dependent on the health of aquatic ecosystems. Most of the drinking water is taken from lakes or rivers. If the lake or river system is unhealthy, the water may be unsafe to drink or unsuitable for industry, agriculture, or recreation. Uses of aquatic ecosystems are thus impaired when these systems are unhealthy. Healthy aquatic ecosystems are those where anthropogenic disturbances have not impaired the natural functioning (e.g., nutrient cycling) nor appreciably altered the structure (e.g., species composition) of the system. These disturbances can be *physical* (e.g., injection of abnormally hot water into a stream), *chemical* (e.g., introduction of toxic wastes at concentrations harmful to the organisms), or *biological* (e.g., introduction and propagation of non-native or exotic animal or plant species). Symptoms of poor ecosystem health include loss of species (loss of biodiversity), accelerated proliferation of organisms (algae blooms caused by an excess of phosphorous and nitrogen compounds in the water i.e. eutrophication), change in chemical properties (like pH) and presence of certain unwanted organisms (like coliform bacteria). Environmental pollution may change the composition, function, and trophic status of ecosystems in reversible or irreversible ways by affecting their biotic or abiotic components. Aquatic pollution comprises all allochthonous inputs and stresses that are in contrast to natural allochthonous input directly or indirectly caused by anthropogenic activities. Possible pathways for aquatic contamination are treated or untreated domestic/ municipal wastewater, surface runoff and industrial wastes (Heininger *et al*., 1998; Tariq *et al*., 1996; Moll and Mansfield, 1991). Pollution of water, soil, sediment or atmosphere proceeds essentially unabated, and the ecosystems serve as repositories for numerous pollutants.

Eutrophication refers to the continuous enrichment of waters by the addition of substances that provide for the increasing growth of aquatic life. Natural eutrophication tends to occur regularly but very slowly, often over a period of hundreds of years. Human activity is generally responsible for rapid eutrophication as household

wastes, agricultural land drainage, and organic industrial wastes or their decomposition products reach the lakes and reservoirs. When gross eutrophication is reached, large, visible aggregations of floating algae bloom extensively, particularly blue-green forms which develop during the late summer. Anacystis (Microcystis), and Anabaena are the most common algae to bloom but others such as Aphanizomenon, Gomphosphaeria, Rivularia, and Oscillatoria may also produce blooms. Less often Spirulina or Arthrospira may be responsible. The blooms may cause unusually severe problems of tastes and odors, filter and screen clogging, and slime accumulation in pipes; some may be toxic, and all may cause fish kills when large numbers of the algae die at about the same time. In the backdrop of above information, this study was carried out to determine the trophic status of the freshwater resources of the Bhandara District of the central India. This district was selected as it is known as the district of lakes and there is abundant water availability.

Materials and Methods

Study Area – Bhandara District

The District of Bhandara in the North-Eastern extreme of the Nagpur Division of Maharashtra State lies between 20°39' and 21°38' north latitudes and 79°27' and 80°42' east longitudes. Geographically, the district lies entirely within the Wainganga basin. Three major tributaries of the Wainganga—the Bagh, the Bawanthari and the Chulband drain the district. The district covers an area of 9280.0 km^2. The district of Bhandara is often called the 'Lake District' of Maharashtra which is well justified by the fact that there are as many as 580 large and 13758 medium and small sized tanks, scattered all over the district. However, there are few comparatively small tanks to the west of the Wainganga in Bhandara District.

Map of Study Region – Bhandara District

Data Collection

Sample Collection

A total number of eleven different lakes were selected for the purpose of data collection. The water samples were collected and processed by following standard methods (APHA, 2005). Prior to sampling, all the glass bottles were thoroughly rinsed and dried in an oven.

Analytical Methods Used

Phosphorous concentration was determined by using Stannous Chloride method and Nitrogen concentration was determined by using UV Spectrophotometric method (APHA, 2005).

Trophic Status of the Water bodies of Bhandara

Three trophic state categories are used to describe lakes as they grow progressively greener: oligotrophic, mesotrophic, and Eutrophic (USEPA, 2010). Trophic state was assessed by: (1) Measuring the levels of nutrients and chlorophyll a in the lake (2) Measuring lake water clarity using a Secchi disk Using these

measurements, classification of lake based on typical ranges for phosphorus, nitrogen, chlorophyll a and Secchi depth values reported in the lake's lifecycle. All the measurements for Chlorophyll *a* and secchi disk were carried out by following standard methods. Chlorophyll *a* was determined by using a handheld fluorometer manufactured by Turner Designs, USA.

Statistical Analysis of Data and Significance Level

Analysis of data was done with the help of suitable statistical tests and with the aid of PASW 18.0 software.

Results and Discussion

Trophic Status of the Water bodies of Bhandara

The determination of lake trophic state is usually made by measuring several diverse criteria, none of which are direct measures of trophic state per se, but rather are indicators of it. Erroneous conclusions may be drawn if only single or few indicators are used, and it is therefore useful to consider an array of different methods. Hence, it is important that the trophic status assessment be carried out with utmost care. Besides, the trophic status knowledge for a particular lake or group of lakes in a geographical area indicates the possible risk of good quality water availability or unavailability. Hence, in this investigation the trophic status of ten different water bodies of Bhandara District of central India was carried out. The results of the study are presented in following **Table 1**.

Table 1: Trophic Status of the different water bodies of Bhandara District

	Total Phosphorus		**Total Nitrogen**		**Chlorophyll *a***		**Secchi Depth (m)**		**Trophic Status**
Gosekhurd	2.77	±0.72	3.00	±0.46	8.20	±1.20	3.20	±0.28	Mesotrophic
Lakhani	1.54	±0.50	5.47	±1.12	7.80	±0.95	3.28	±0.34	Mesotrophic
Lakhandur	1.50	±0.42	1.10	±0.00	6.89	±3.20	3.94	±0.85	Mesotrophic
Chandpur	1.33	±0.12	0.80	±0.35	3.48	±0.52	6.24	±0.48	Mesotrophic
Bhandara Lake	1.97	±0.55	3.77	±0.76	10.40	±3.24	2.62	±0.34	Mesotrophic
Bhandara River	1.57	±0.35	0.67	±0.12	5.27	±4.23	4.10	±0.52	Mesotrophic
Wahi Lake	1.50	±0.38	5.33	±0.25	11.82	±3.38	2.87	±0.44	Mesotrophic
Shivani Bandh	1.37	±0.12	0.33	±0.15	9.01	±2.65	4.16	±0.62	Mesotrophic
Pauni-Near Bridge	1.57	±0.25	1.20	±0.56	7.45	±2.48	4.86	±0.27	Mesotrophic
Khurada Lake	1.77	±0.45	5.20	±0.17	9.47	±2.62	4.27	±0.54	Mesotrophic
Balsamudra Lake	1.43	±0.06	4.37	±1.16	12.56	±3.31	2.18	±0.19	Eutrophic

Total Phosphorous (TP)

Subsequent to sampling and analysis, the raw data was analysed statistically. The average TP varied between 1.33~±0.12 and 2.77±0.72 ppm, with highest recorded at Gosekhurd and the lowest at Chandpur lake. The means TP obtained from all the lakes were compared using ANOVA technique, and it was observed that there is a significant ($P<0.05$) difference in the TP of surface water.

Total Nitrogen (TN)

The average TN varied between 0.33~±0.15 and 5.47±1.12 ppm, with highest recorded at Lakhani lake and the lowest at Shivani Bandh lake. The comparative analysis of mean TN obtained from different lakes showed significant (ANOVA, $P<0.01$) difference in the TN of surface water.

Chlorophyll *a*

The average Chlorophyll *a* varied between 3.48~±0.52 and 12.56±3.31 gm^{-3}, with highest recorded at Balasamudra lake and the lowest at Chandpur lake. Like, TP and TN, the chlorophyll a concentration also showed significant ($P<0.05$) difference.

Trophic Status of the Lakes

Table 1 indicates trophic status of different water bodies of Bhandara District. Based on the results of data of total phosphorous, total nitrogen, Chlorophyll *a* and Secchi depth, it is observed that Gosekhurd, Lakhani, Lakhandur, Chandpur, Bhandara Lake, Bhandara River, Wahi Lake, Shivani Bandh, Pauni-Near Bridge and Khurada Lake were mesotrophic water bodies whereas Balsamudra Lake was eutrophic water body. Thus, it may be concluded from the study results that majority ($P<0.05$) of water bodies of Bhandara District are mesotrophic.

The study results showed that the majority of Lakes in the Bhandara District are mesotrophic, with one being Eutrophic. The large number of lake with mesotrophic status is a cause of concern, especially in view of the quality of water, which is needed for different types of uses. As stated by Agrawal (1999), shift in the nutrient load is a major cause for change in trophic status of a water body. This shift (in nutrient load) can be attributed to surface run off, traditional agricultural practices with application of fertilizers, stress passing by large cattle population, domestic use (like water use for bathing, washing, cattle wading, waste disposal, etc.), scant respect for rules, regulations and laws that are laid down for preserving the water bodies. Since, almost all the above mentioned activities are inherent to the study area, the lakes appear to be at risk of nutrient pollution. Srinivasu (2004) has also stated that there is a need to improve the data repository so as to delineate models that can be used for effective nutrient pollution management. Often, there is no exit of the nutrients and hence, once they are in the system it is very difficult for the different local governing bodies to manage lake water quality. For example, Anshumali & Ramanathan (2007) have stated that the P resides in the sediment layer and it becomes a source initially for the detritus microbes. Moreover, Mandal et al., (2014) have stated that there is a need to monitor the autochthonous as well as allochthonous P input in the lake system for preserving its trophic state (oligotrophic or mesotrophic).

Conclusions

The impact of human activity on water resources and the need for the rehabilitation of watersheds, watershed ecosystems needs an in depth understanding of the limnology. With all of the demands humans place on the hydrosphere, as well as climate changes which have led to droughts, the amount of available freshwater is decreasing at an alarming rate. In view of this, this study focused on the assessment of trophic status of the selected water bodies of Bhandara District of Maharashtra. on the basis of the study results it is concluded that majority ($P<0.05$) of water bodies of Bhandara District are of mesotrophic trophic status and have high nutrient load.

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